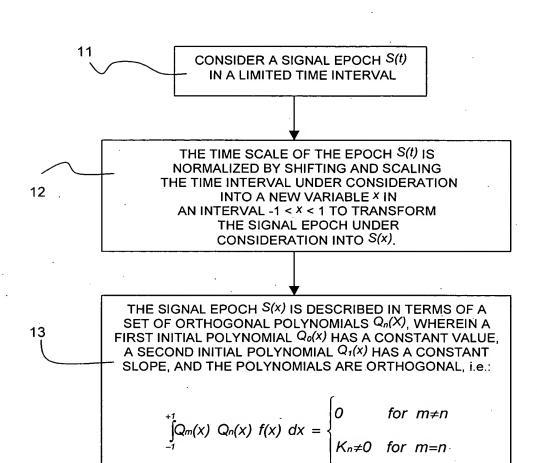Title: Signal Filtering Using Orthogonal Polynomials and
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FIGURE 1

11

> CONSIDER A SIGNAL EPOCH $S(t)$
> IN A LIMITED TIME INTERVAL

12

> THE TIME SCALE OF THE EPOCH $S(t)$ IS
> NORMALIZED BY SHIFTING AND SCALING
> THE TIME INTERVAL UNDER CONSIDERATION
> INTO A NEW VARIABLE x IN
> AN INTERVAL $-1 < x < 1$ TO TRANSFORM
> THE SIGNAL EPOCH UNDER
> CONSIDERATION INTO $S(x)$.

13

> THE SIGNAL EPOCH $S(x)$ IS DESCRIBED IN TERMS OF A
> SET OF ORTHOGONAL POLYNOMIALS $Q_n(X)$, WHEREIN A
> FIRST INITIAL POLYNOMIAL $Q_0(x)$ HAS A CONSTANT VALUE,
> A SECOND INITIAL POLYNOMIAL $Q_1(x)$ HAS A CONSTANT
> SLOPE, AND THE POLYNOMIALS ARE ORTHOGONAL, i.e.:
>
> $$\int_{-1}^{+1} Q_m(x)\ Q_n(x)\ f(x)\ dx = \begin{cases} 0 & \text{for } m \neq n \\ K_n \neq 0 & \text{for } m = n \end{cases}$$
>
> WHERE $f(x)$ IS A FUNCTION OF x AND K_n IS A CONSTANT
> DEPENDING ONLY ON THE ORDER n.

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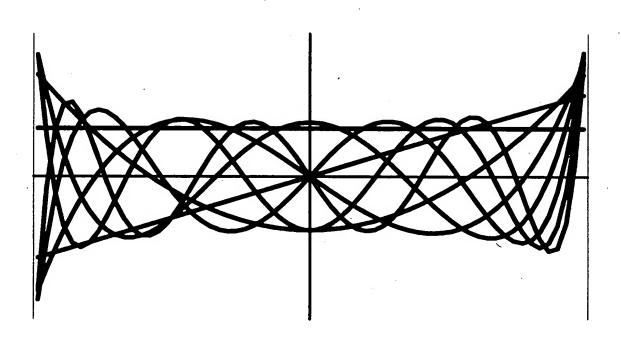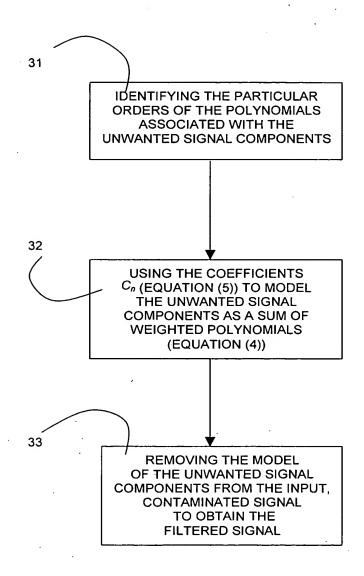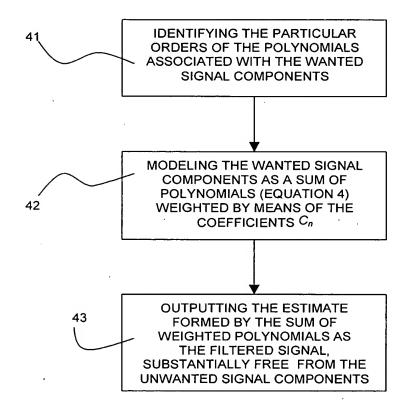Atty: TATurano/SKWitonsky
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FIGURE 2

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FIGURE 3

31

IDENTIFYING THE PARTICULAR
ORDERS OF THE POLYNOMIALS
ASSOCIATED WITH THE
UNWANTED SIGNAL COMPONENTS

32

USING THE COEFFICIENTS
C_n (EQUATION (5)) TO MODEL
THE UNWANTED SIGNAL
COMPONENTS AS A SUM OF
WEIGHTED POLYNOMIALS
(EQUATION (4))

33

REMOVING THE MODEL
OF THE UNWANTED SIGNAL
COMPONENTS FROM THE INPUT,
CONTAMINATED SIGNAL
TO OBTAIN THE
FILTERED SIGNAL

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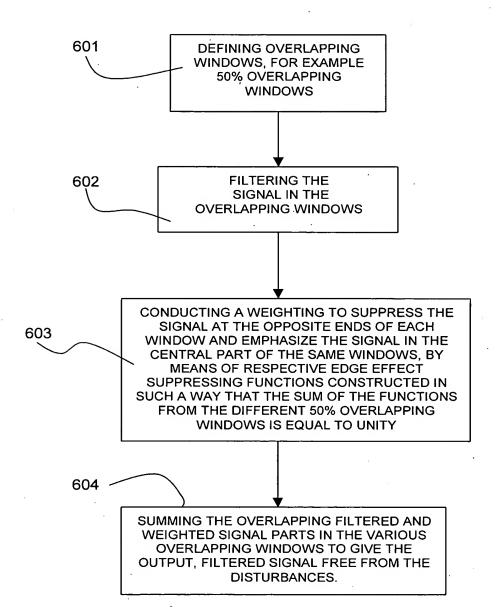Sheet 4 of 12

FIGURE 4

41 — IDENTIFYING THE PARTICULAR ORDERS OF THE POLYNOMIALS ASSOCIATED WITH THE WANTED SIGNAL COMPONENTS

42 — MODELING THE WANTED SIGNAL COMPONENTS AS A SUM OF POLYNOMIALS (EQUATION 4) WEIGHTED BY MEANS OF THE COEFFICIENTS C_n

43 — OUTPUTTING THE ESTIMATE FORMED BY THE SUM OF WEIGHTED POLYNOMIALS AS THE FILTERED SIGNAL, SUBSTANTIALLY FREE FROM THE UNWANTED SIGNAL COMPONENTS

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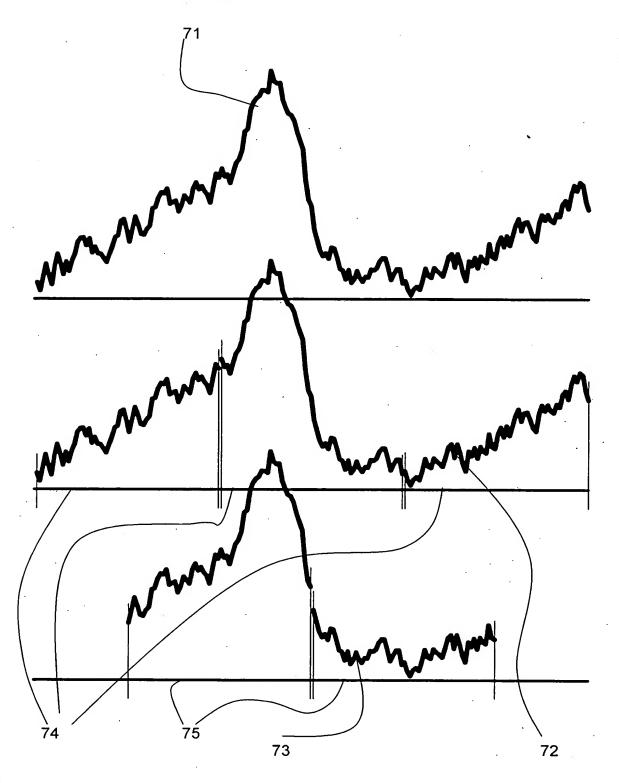Atty: TATurano/SKWitonsky ·
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FIGURE 5

51

USING THE COEFFICIENTS C_n
AS ESTIMATES OF THE
SIGNAL STRENGTH

ADDING THE SET OF COEFFICIENTS C_n TO
PROVIDE AN ESTIMATE OF THE SIGNAL
STRENGTH, FOR EXAMPLE BY SUMMING
THE COEFFICIENTS C_n ON A SQUARE LAW
BASIS TO GIVE AN ESTIMATE OF THE
SIGNAL POWER, SUCH AS BY SUMMING
THE SQUARED COEFFICIENTS C_n
WEIGHTED BY AN APPROPRIATE
FUNCTION OF THE ORDER n

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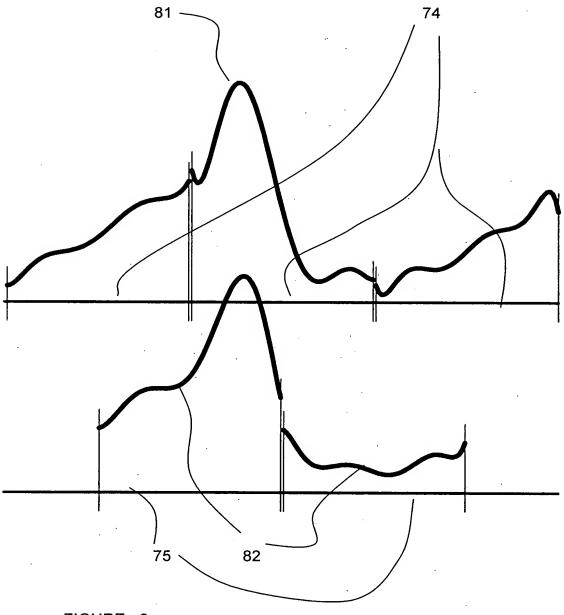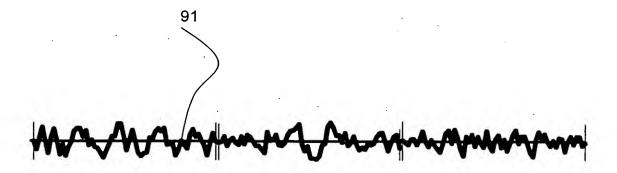Atty: TATurano/SKWitonsky
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FIGURE 6

601

DEFINING OVERLAPPING
WINDOWS, FOR EXAMPLE
50% OVERLAPPING
WINDOWS

602

FILTERING THE
SIGNAL IN THE
OVERLAPPING WINDOWS

603

CONDUCTING A WEIGHTING TO SUPPRESS THE
SIGNAL AT THE OPPOSITE ENDS OF EACH
WINDOW AND EMPHASIZE THE SIGNAL IN THE
CENTRAL PART OF THE SAME WINDOWS, BY
MEANS OF RESPECTIVE EDGE EFFECT
SUPPRESSING FUNCTIONS CONSTRUCTED IN
SUCH A WAY THAT THE SUM OF THE FUNCTIONS
FROM THE DIFFERENT 50% OVERLAPPING
WINDOWS IS EQUAL TO UNITY

604

SUMMING THE OVERLAPPING FILTERED AND
WEIGHTED SIGNAL PARTS IN THE VARIOUS
OVERLAPPING WINDOWS TO GIVE THE
OUTPUT, FILTERED SIGNAL FREE FROM THE
DISTURBANCES.

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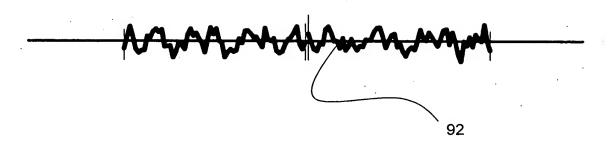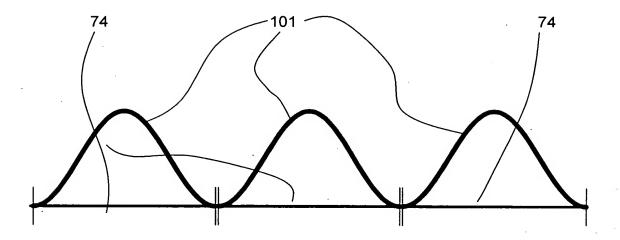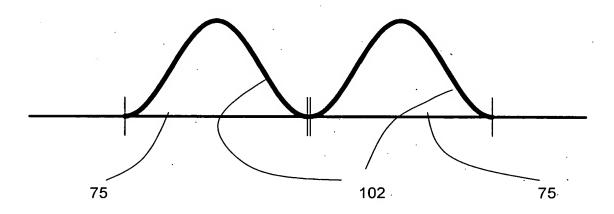Atty: TATurano/SKWitonsky
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74   75   73   72

FIGURE 7

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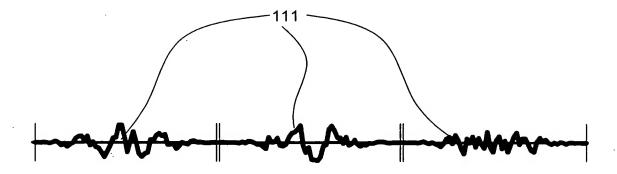Atty: TATurano/SKWitonsky
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81   74

75   82

FIGURE 8

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FIGURE 9

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FIGURE 10

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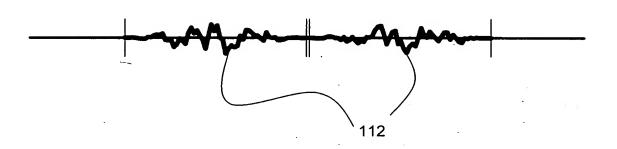Atty: TATurano/SKWitonsky
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FIGURE 11

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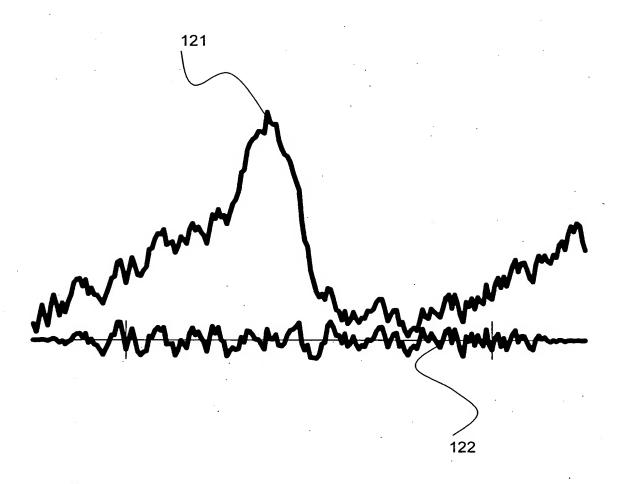Atty: TATurano/SKWitonsky
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FIGURE 12